OBSERVATIONS ON THE LENGTH-WEIGHT RELATIONSHIP OF THE FISH *RASBORA DANICONIUS* (HAM.-BUCH.)[1]

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(*With two text-figures*)

The present paper deals with the study of length-weight relationship in a cyprinid fish, *Rasbora daniconius*. The equations expressing this relationship in both the sexes of the adult fish are further studied to verify cube relationship (Le Cren 1951) between these two measurements. To see whether the two regression equations obtained here, one in the case of each of the females and the males, differ significantly from each other, the test of analysis of covariance is performed.

INTRODUCTION

Since growth generally contributes to the increase of both, length and weight of a fish, the length-weight relationship is an interesting aspect of study to establish the statistical relationship between these two measurements. This relationship was expressed by earlier workers by the cubic formula, $W = aL^3$, wherein it is suggested that the weight (W) of the fish is equal to the product of the cube of the length (L) and a constant (a). Crozier and Hecht (1913) found this cubic law inadequate to explain the length-weight relationship in fishes. The general assumption that the weight of the fish varies as the cube of its length did not show accuracy in the empirical results. Allen (1938) supported the cube law in case of fish which maintain the same shape. Therefore to be able to explain the varying power value of L in case of fish available in nature in general, many workers adopted the parabolic equation of the form, $W = aL^b$. Hile (1936) and Martin (1949) in this connection found that the power values of b usually varied between 2.5 and 4 in different fishes. Le Cren (1951) revealed that as retaining either of the shape of the body outline, or of the constant specific gravity of the tissues is almost an impossible event, the relationship may depart from cube law proposed for an ideal fish. Hence he admitted the use of b power formula and also pointed out the superiority of b power formula over cubic formula for the reason that the former besides being useful in finding out weight and length measurements may also be used for indicating the condition factor or ponderal index, spawning season and the taxonomic differences and events in the life history, such as, metamorphosis and the onset of maturity.

MATERIALS AND METHODS

Adult specimens, freshly collected from river Kham, near Aurangabad were brought to the laboratory, cleaned under tap water and immediately after removing the body moisture with the help of blotting paper, their weight and total length measurements were noted ac-

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curately. The sex was recorded by opening the abdomen. Thus 3085 adult specimens, comprising 2152 females in the range of 36-160 mm and 933 males in the range of 36-123 mm were considered in this study. The indeterminants below 36 mm. being very rare in catch, could not be obtained regularly and sufficiently and therefore, they were not included in the present study. The length-weight data of females and the males were then analysed separately and grouped into various length groups of 10 mm size interval. The mean values of length and weight representing each length group were then calculated in respect of the number of specimens in each length group. These mean values were used in the calculation of length-weight relationship.

The general parabolic form of equation, $W = aL^b$ was used to show the statistical relationship between length and weight. Since the weight-length ratio is a power relationship, logarithms were used, so that the exponential relation could be expressed by a linear equation:

Log W = Log a + b Log L

which corresponds to the regression line equation,

Y = a' + bX.

where, Y = Log W. X = Log L — are the two variates and

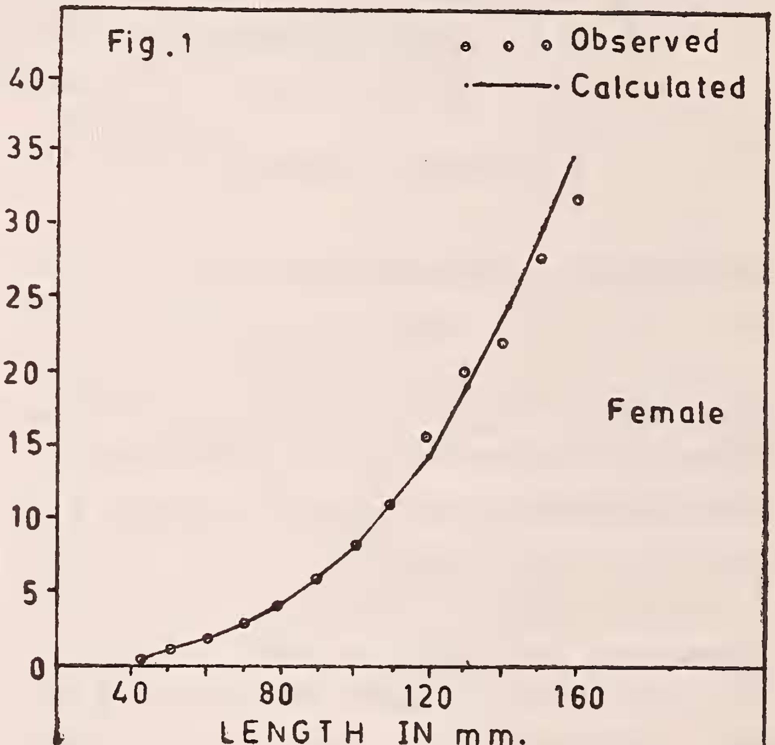
a' = Log a and b — are the constants.

Thus, the above equation with weight (W) and length (L) in logarithmic form can be treated as the equation of regression line, Y = a' + bX, wherein the values of constants, a' and b are to be determined. The following equations have been used for this purpose.

$$b = \frac{\Sigma xy}{\Sigma x^2} \quad \text{and} \quad a' = \frac{\Sigma Y - b \; \Sigma X}{n}$$

where X and y are the logarithmic forms of length and weight respectively and n, the number of the group samples, *x and y* are the deviation values of X and Y respectively from their mean i.e. $X - \overline{X} = x$ and $Y = \overline{Y} = y$.

The calculated value of Y for each size group was then estimated by substituting the values of X and the constants a′ and b in the equation, y = a′ + bX. The equation, $W = aL^b$, showing exponential relationship between length and weight was expressed, in females and males, separately. W was calculated for every mean total length (L) and the relation-



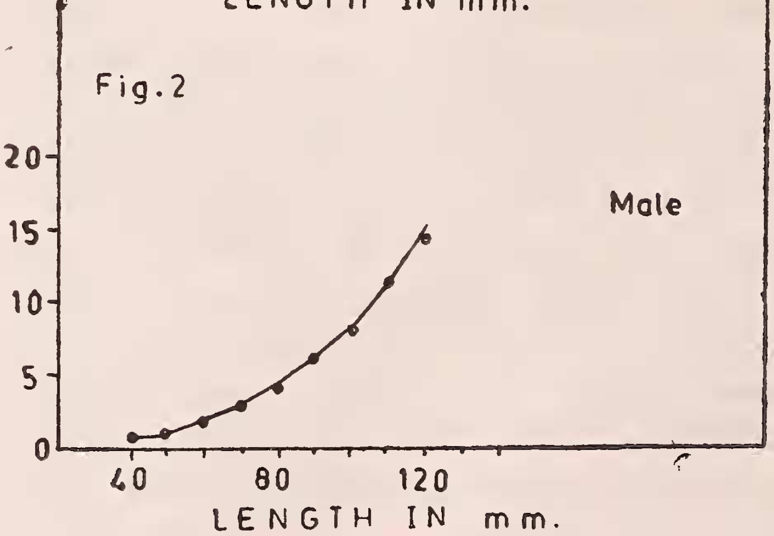


Fig. 1. Graph showing length-weight relationship in female *R. daniconius*.

Fig. 2. Graph showing length-weight relationship in male *R. daniconius*.

ship between these two measurements is shown graphically for females and males in Figs. 1 and 2 respectively.

Results

The equations showing the relationship between length and weight in females and males are expressed as below:

$$\text{Females: } W = 0.003980\, L^{3.1524}$$

$$\text{Males : } W = 0.003007\, L^{3.2190}$$

and in the linear form of regression line equation as:

$$\text{Females: } \text{Log } W = -2.4002 + 3.1524 \text{ Log } L$$

$$\text{Males : } \text{Log } W = -2.5218 + 3.1290 \text{ Log } L$$

The data of length-weight relationship for females and males were analysed to test whether the two regression equations obtained above differed significantly from each other. The test was performed by the method of analysis of covariance (Snedecor 1961). Particulars of the analysis of covariance are given in Table 1. It is evident therefrom that the length-weight relationships both in females and males do not differ significantly at 5% and 1% level of significance.

Table 1

Comparison of the regression lines of the length-weight relationship in *R. daniconius*

test of significance by analysis of covariance

Sr. No.	Source of variation	D.F.	$\sum x^2$	$\sum y^2$	$\sum xy$	Regression coefficient	Deviation from regression D.F.	S.S.	M.S.	Calculated F	Tabulated F	Remarks
1.	Females	12	0.4022	4.1316	1.2679	3.1524	11	0.1347				
2.	Males	8	0.1982	2.0577	0.6380	3.2190	7	0.0040				
3.	Deviation from individual regressions within sexes.						18	0.1387	0.0077	15.4	5% in between 245.9 (15 d.f.) and 248.0 (20 d.f.)	Females and males do not differ significantly
4.	Differences between regressions.						1	0.0005	0.0005		1% in between 6157 (15 d.f.) and 6209 (20 d.f.)	
5.	Deviation from total regression.	20	0.6004	6.1893	1.9059	3.1744	19	0.1392				

The extent of association between X and Y values also was tested by estimating the coefficient of correlation (r). For females the r was found to be 0.9836 (d. f. 12, r, 5% = 0.532 and r, 1% = 0.661) and for males 0.9991 (d. f. 8, r, 5% = 0.632 and r, 1% = 0.765). This showed that in both the sexes r was perfectly significant indicating a good association between the two measurements of length and weight.

The regression coefficient, b is 3.1524 in case of females and 3.2190 in case of males. Both the values of b are slightly greater than 3 and thus closely, if not perfectly, support the cube law. With a view to see, whether the regression coefficient b differed from 3, the 't' test (Ostle 1966) was performed. In females 't' was found to be 2.9308 (d. f. 11, t. 5% = 2.201) and in males 5.2771 (d. f. 7, 't', 5% = 2.365). The 't' test revealed significant difference of b from 3 at 5% level of significance in both the sexes, thus showing thereby 'b' slightly higher than 3.

The calculated value of W for every mean L has been graphically depicted in Figs. 1 and 2 in case of females and males respectively. Both the graphs are curvilinear. The observed values of weight for different size groups, shown as encircled dots, are seen to lie close to the respective calculated values of weight.

As can be seen from Figs. 1 and 2 both females and males upto 80 mm in length increase in weight at a lesser rate than in the subsequent size groups. This may be attributed to the slow gonadal growth generally found in the first time breeders.

Discussion

The present results coincide with the observations of several workers. Prabhu (1955) worked on length-weight relationship of *Trichiurus haumela* and inferred that the weight increase in proportion to its length showed a normal pattern (the value of b was noted as 3.0819). Bhatnagar (1963) worked on *Puntius kolus* and found that the values of 'b' were slightly higher than 3 in males and females but not so in juveniles. Misu (1964) and Narasimhan (1970) worked on the length-weight relationship of *Trichiurus lepturus*, the former from East China Seas and Yellow Sea and the latter from Kakinada, India, and showed that there was a deviation from the so called cube law and weight of the fish increased at a rate higher than the cube of the length. Chatterji *et al.* (1977) worked on the length-weight relationship of a carp, *Labeo bata* and showed that the fish did not strictly follow the cube law and the weight increased at a rate more than the cube of the length.

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